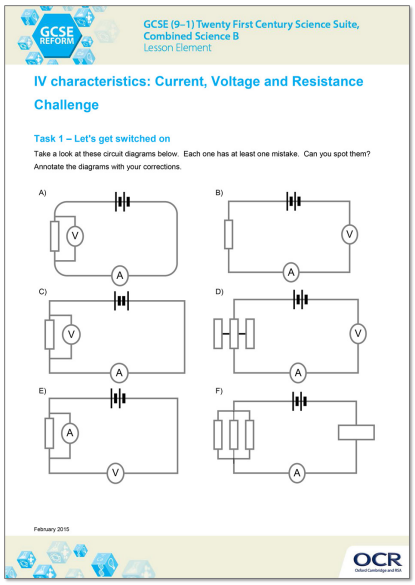
IV characteristics: Current, Voltage and Resistance Challenge

PROVISIONAL

Instructions and answers for teachers

These instructions should accompany the OCR resource 'IV characteristics: Current, Voltage and Resistance Challenge' activity *which supports OCR GCSE (9–1) Twenty First Century Science Suite, Combined Science B.*



Learning Outcomes

P2.2 (4) recall and apply the relationship between I, R and V to calculate the currents, potential differences and resistances in D.C. series circuits

P2.2 (8) recall that for some components the value of R remains constant (fixed resistors) but that in others (heating elements, lamp filaments) it can change as the current changes

P2.2(10) represent circuits with the conventions of positive and negative terminals, and the symbols that represent common circuit elements, including lamps, diodes, LDRs and thermistors

P2.2 (11) use graphs to explore whether circuit elements are linear or non-linear and relate the curves produced to their function and properties

Task instructions

This resource has been designed to encourage the learners to perform the investigation independently with little teacher input. Before the lesson, learner activity sheets should be prepared for every learner.

PROVISIONAL

This resource is an exemplar of the types of materials that will be provided to assist in the teaching of the new qualifications being developed for first teaching in 2016. It can be used to teach existing qualifications but may be updated in the future to reflect changes in the new qualifications. Please check the OCR website for updates and additional resources being released. We would welcome your feedback so please get in touch.

February 2015

Introduction

This resource provides a structure for a learner-led investigation into the IV characteristics of a fixed resistor, a filament lamp and a diode. The aim of this resource is to minimise teacher input, and allow learners to develop their practical and thinking skills, and their independence. Each task in the learner activity sheets has clear instructions for learners to follow, allowing them to drive their own learning at their own pace.

This lesson element is designed to be an extension or 'How Science Works' activity, or as a way of deepening the understanding of the nature of resistance, and the definition of electron flow for electrical current.

It is assumed that learners already have a working knowledge of the nature of voltage and current from KS3, and are able to draw and interpret circuit diagrams. However, there are opportunities for teachers to check this prior knowledge, and to elicit and discuss common misconceptions.

Learners commonly misunderstand how and where to connect voltmeters and ammeters. There is also an opportunity to discuss the difference between Input Voltage (which could be described as a measure of the amount of energy being supplied to the whole circuit) and the Voltage across the component (which could be described as a measure of the amount of energy used by the component. This is more correctly called the 'potential difference.') In an ideal world, Input Voltage = Potential difference. It is likely that the input voltage (e.g. 12V) will appear to be slightly higher than the voltage across the component (e.g. 11.5V). This is because some of the energy being supplied to the circuit is lost as heat in the connecting leads, so not all the input voltage is being used across the component.

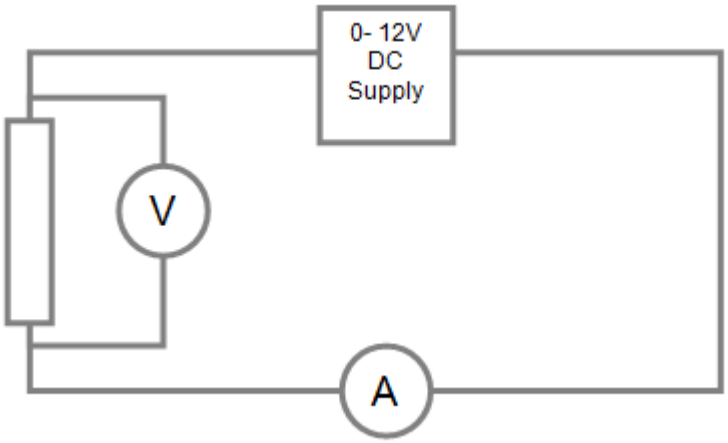
Task 1 – Let's get switched on

As the learners enter the room, hand them their activity sheets, and highlight to them that the starter task is on the front of the booklet. They are to read the instructions and act upon them. After around five minutes, there is an opportunity to quickly discuss with the class their thoughts and to check their answers.

(Circuit A has rounded leads, Circuit B has a voltmeter set up in series, C has one cell facing the wrong way, D has three resistors incorrectly connected in parallel, E has the ammeter in parallel and a Voltmeter is series, and F has a resistor symbol on the right hand side incorrectly drawn at the wrong orientation.)

Task 2 – Planning

Firstly, provide groups with the equipment needed (a fixed resistor of 10 Ω, a 12V filament lamp, a Light-Emitting Diode, a variable DC power supply, a voltmeter, an ammeter and connecting leads).
The learners are then required to use their prior knowledge to build a suitable circuit for measuring the current through the resistor, the voltage across the resistor, and have a way of varying the voltage. The circuit will resemble this diagram:



Teachers may want to prompt where necessary. Learners can check with teachers before moving on to task 3.

Task 3 – Testing

Learners are then able to collect various readings from the voltmeter and ammeter as they vary the input voltage. They can then repeat the experiment for both the LED and bulb, before plotting I-V graphs on separate graph paper.

Task 4 – Comparisons

Learners then compare their graphs to the sketches provided. The first sketch resembles the graph for the fixed resistor, the second graph the LED, and the third the graph for the filament lamp.

Task 5 – Analysis

The learners are to answer the questions in task 5, using either their knowledge, research from a text book or from teacher input.

Answers to questions

1. The graphs are not straight lines/do not show a directly proportional relationship.
2. The bulb heats up as it is switched on. The flowing electrons cause friction as they flow past the atoms. This friction creates heat, which in turn causes the atoms to vibrate more. As the atoms vibrate faster, it makes it harder for the electrons to flow. The vibrations are causing an increase in overall resistance. This means that increases the voltage has a smaller effect on the increase in current, meaning that the line does not increase proportionally.
3. (i) there will be no effect on the shape
   (ii) there will be no effect
   (iii) No graph will be able to be drawn, as there will be no readings. This is because the LED will only allow current to flow through it in one direction. Effectively, the LED has infinite resistance when the current is flowing in the wrong direction.

Task 6 – Reflection

This is an opportunity for learners to summarise their learning, and to ask questions about the topic. These questions could potentially be set as a homework task or a peer response task where learners answer each other's questions.

Supporting Information

As this lesson element is designed to put the onus on the learners to do the majority of the work without teacher input, teachers should prepare one of the activity sheets for each learner. The tasks within the activity sheets should be virtually self-running, and will only require a little prompting and clarification from the teacher.

It is highly recommended that teachers conduct the practical themselves in advance of this lesson. This way, teachers can check that the equipment is suitable, and obtain a set of results that is known to produce the required IV characteristic patterns for each component. If, for some reason, the learners are unable to reproduce these patterns themselves, the teacher can then provide the set of known results to the learners so that they can continue with the tasks they have been set.

Teachers should also be sure they read and understand the answers to the questions in Task 5.

For a suitable overview of the required subject knowledge, the following websites are recommended.

http://www.bbc.co.uk/education/guides/z88hvcw/revision

(An overview of the nature of current, voltage and resistance.)

http://www.bbc.co.uk/education/guides/zqqfr82/revision

(An explanation of the IV characteristic graphs for fixed resistors, filament lamps and diodes.)

Ideally, learners should be able to access a computer during the lesson. If a learner is struggling with a question, they should be encouraged to find out the answer themselves by researching the topic on the suggested websites, or similar. If a computer is not available, a course text book could be used for a similar purpose.

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